

Reply Comments on Proceeding 03-104, Broadband over Power Lines (BPL)

Submitted by Gary A. Breed

I have been a radio communications professional since 1971. My experience includes the design, construction and proof-of-performance of AM, FM and TV broadcasting; microwave, satellite and CATV systems; plus a wide range of other radio-frequency and microwave systems and circuits. My participation in the industry has been as an engineer, consultant and technical publisher. In addition, I have been an amateur radio operator since the age of 12 and hold Amateur Extra Class license K9AY. These comments are made after applying both theoretical analysis and practical experience to the comments that have been filed regarding BPL.

I. AC Power Lines as RF Transmission Lines

In the matter of BPL, the core technical issue is not in dispute: 50/60 Hz power transmission lines are very poor radio-frequency transmission lines. The primary reasons for this poor performance are well-understood:

1. From the comments of the IEEE Power System Relaying Committee (IEEE PSRC):

"The electric power distribution system has many configuration variations. It is impossible to image or specify a 'standard' distribution feed model that represent all real systems. The system may contain conductors that approach 'critical wavelengths', tuned stub, have connected non-linear devices, and have configuration variations in height and separation. There may be parallel conductors on the poles or buried conductors beneath. The feeder conductors may be overhead, buried, or a combination of the two. The customer load connections may be on, two or three phase. Additionally, outages due to maintenance, construction or storm damage may mean the feeder will be connected to the system in a non-typical configuration to maintain the customer's supply of power."

The inconsistency of construction means that balance cannot be assured, operating impedance is variable, and coupling effects due to nearby lines and structures cannot be accurately predicted. These factors all reduce transmission efficiency, with nearly all the losses through radiation.

2. The dimensions of the system are physically large at the frequencies proposed (2 to 80 MHz), ranging from a large fraction of a wavelength at 2 MHz, to several tens of wavelengths at 80 MHz.

These large dimensions are impractical for transmission lines and, in fact, are more suitable for an antenna. As such, the system will actually radiate and receive signals more efficiently than it will communicate intended signals. Over the proposed frequency range, propagation via skywave exists at all or part of the time, which will magnify the effects of both radiation from the system and interference inflicted on the system from existing licensed radio services in the HF band.

3. The system is interrupted at regular intervals by transformers that, by their inherent design and construction, block RF signals. In addition, switching systems can alter the interconnection of the various branches of the system.

The circuitry used to bridge transformers may be either passive or active. Passive bridging circuitry will increase the RF 'size' of the system by

eliminating the filtering action of the transformers, increasing both radiated and interfering signals. Active bridging circuits require additional signal sources, which increases the total power input to the system, thereby increasing its total radiation. Active circuits also decrease system reliability by placing sensitive electronic devices in a harsh environment that is regularly subject to surges from lightning and system switching transients.

Summary of Section I --

The laws of physics determine the behavior of the power line distribution system at radio frequencies. Without a major change in the physical configuration of power distribution lines to make them compatible with the transmission of radio-frequency signals, any attempt to send such signals over the power lines will result in the majority of the power being radiated from the system, where it can interfere with the reception of licensed radio services.

II. Response to Claims and Assertions by Proponents of BPL

Many of the supporting comments for BPL include incorrect or contradictory statements. It is hoped that the Commission and its staff will recognize these statements and reject them as appropriate. I have included a few examples as illustration.

1. From the comments of Satus, Inc.:

"It is important to note that utility companies report seven times larger emissions from [sic] a DSL system on telephone wires than from a BPL. Also important to note is that twisted pair wires, like telephone wires, have in most cases larger emission and harmonics than power line wires."

The second sentence of this statement is simply not true. Twisted pair wires are inherently balanced, effectively containing the signals they carry by equal-and-opposite currents in the two wires, with the twist introduced to maintain balance in the presence of external objects. As noted in Section I, the inherent imbalance in power line wires makes them excellent radiators, far worse than any twisted pair. Any good communications textbook will illustrate the effectiveness of twisted pair wiring. The best evidence is the extremely low radiation from nearly all Ethernet network cables, which use twisted pairs to exchange high speed/high frequency data.

2. From the comments of Southern Linc, Southern Telecom, Inc, and Southern Company Services, Inc. (Southern):

"The FCC has already issued a number of Experimental Licenses related to BPL, and data generated in these and other trials has proven that the technology is viable and potentially compatible with other broadband platforms."

These trials have been of small size, not the miles-and-miles of transmission lines that would ultimately be part of a BPL system. The trials have been tightly controlled by the parties involved, not independently evaluated by disinterested third parties.

While the Southern comments, and those of others, claim that BPL is "viable", they do not claim that BPL meets, or will be able to meet current Part 15 standards for radiated emissions. In fact, most of the technical discussion in their proposals involves how Part 15 should be changed (relaxed) to allow BPL.

3. On the subject of Part 15, the IEEE PSRC comments recommend that a standard test setup and procedure using a line impedance stabilization network (LISN) be established for BPL equipment, yet it also states that, "Due to the variations in the configuration of the power system, a defined measurement based on the equipment alone would not be sufficient to demonstrate compliance of either the conducted or radiated signal. This type of contradictory information illustrates how difficult it is to "force" BPL to fit into current Part 15 FCC regulations, which are in place to protect licensed users of the spectrum from unwanted interference. It is my view that BPL cannot be prevented from causing interference, and changing Part 15 is not a valid response to this issue.

4. The comments from Southern, and from the Omaha Public Power District (OPPD) argue heavily for enhanced internal operations using BPL, yet the comments of IEEE PSRC emphatically state that BPL will not be reliable enough for such operations. There may be value to the utilities in remote meter reading and more extensive system monitoring, but claims of greatly improved internal operations is certainly a minor point, not the high priority that Southern and OPPD claim.

Summary of Section II --

The proponents of BPL have not presented evidence that this service -- as it is presently designed -- can acceptably fit into the existing structure of worldwide licensed operations (amateur, shortwave broadcasting, public safety, point-to-point, marine and military services). Rather than relax Part 15 and its important protections against interference to these services, further study and development is required before implementing BPL.

Closing Comments --

I applaud the efforts of the FCC to encourage innovation in communications. As a communications professional, my livelihood depends on a robust industry. Many new systems have grown and flourished because of the foresight of the Commission. Wireless telephony, wireless networking and ISM band spread spectrum short-range wireless systems of all types are good examples.

However, when a new proposal has not yet proven that it is technically sound and compatible with existing systems, it should be studied, modified, and allowed to either develop the necessary techniques or be abandoned. The recent action to introduce Ultra Wide Band (UWB) in a limited and cautious manner demonstrates that the FCC can address controversial new technologies in a reasoned manner. I hope the same reasoned approach will be taken with BPL.

There are numerous examples that are precedent for a modest delay to allow further development. Additional testing of currently proposed systems by independent third parties is prudent, in particular, the thorough characterization of the RF radiation from the power distribution infrastructure. Alternatives such as prohibited bands or licensed channelized operation should also be explored.

Sincerely,

Gary A. Breed